Hierarchical Structure Analysis of Interstellar Clouds Using Non-Orthogonal Wavelets

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We use Laplacian pyramid transforms (LPT), a form of non-orthogonal wavelets, to analyze the structure of interstellar clouds. These transforms arc generally better suited for analyzing structure than orthogonal wavelets because they provide mom flexibility in the structure of the encoding functions - here circularly symmetric bandpass filters - and are computational y efficient, Pyramid transforms provide a means to decompose images into their spatial frequency components such that all spatial scales arc treated in an equivalent manner. This method of signal decomposition is the basis of all scale invariant multiresolution representations such as pyramids and wavelets. The LPT is applied to CO maps of Barnard 5 (Langer, Wilson, and Anderson 1993) and IRAS 100 and 60 μm maps of cirrus clouds. In the ^{13}CO maps of B5, for example, wc identify sixty different fragments and clumps, as well as several cavities, or bubbles, Many features show evidence of hierarchical structure, with most of the power in the largest wavelengths. The clumps have a more chaotic structure at small wavelengths than expected for Kolmogorov turbulence, and a mass distribution proportional to $M^{-5/3}$. The structure analysis is consistent with a picture where gravity, energy injection, compressible turbulence, and coalescence play an important role in the dynamics of B5. Pyramid transforms are important tools to analyze, detect, and characterize of structural components in astronomical maps.

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